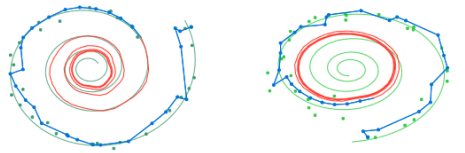
Study / Masters Thesis

Institut für
Mechatronische Systeme
Leibniz Universität Hannover
imes

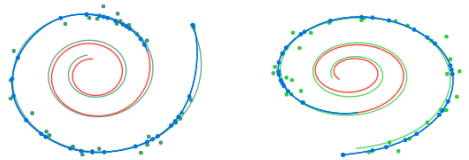
Physics-informed Machine Learning for Time-Series Modeling: Implementation and Comparative Study

Research Overview:
Standard machine learning approaches often suffer from data inefficiency, poor generalization and questionable physical interpretability. For use in real-world systems, embedding physical knowledge about the systems behavior is promising. To this end, a comparative study of recent advances for time-series modeling should be conducted, e.g. investigating:

- Gaussian Process Port-Hamiltonian Systems
- Lagrangian Neural Networks
- (Port-)Hamiltonian Neural Networks
- NeuralODEs



(a) Recurrent Neural Network



(b) Latent Neural Ordinary Differential Equation

Work plan:

- Literature research on recent physics-informed machine learning methods
- Implementation and comparison in simulation studies
- Implementation and comparison based on real-world data (e.g., an inverted pendulum)
- Documentation and illustration of the results in suitable graphics

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Prerequisites:

- Knowledge in machine learning (e.g, by visiting the modules “Machine Learning” or “Data- & Learning-based Control”)
- Advanced knowledge in Python or Julia, preferably in the context of estimation and control.
- Good English skills and eagerness to read scientific papers.

Date:

From November 2024.

This generally formulated topic will be further specified in an individual discussion. For Master's theses, more extensive and more demanding goals are defined than for Bachelor's theses and student research projects.